USB/DMX512 Co

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All amateur disc jockeys and light jockeys dream about it: a DMX512 converter not bigger than an XLR connector! But at a retail price of more than 500 pounds for this type of accessory, the dream may never come true. Here is a project that will make some on the dance floors very happy... the DMX converter of their dreams and for only a few pounds.

The USB/DMX512 converter described in this article connects to any computer equipped with a USB connector and a Windows® 98 OS or later. The USB (bus) supplies the current necessary to power the circuit we've designed. The proposed setup transmits the 512 DMX channels at a rhythm of approximately 42 frames per second using a computer equipped with a USB 2.0 interface. The maximum speed defined by the standard is 44 frames per second. Note that this transmission rate may be a little less with a USB 1.0 connection. The printed circuit board we designed for the converter measures 14 mm by 26 mm and employs SMD components.

Important note: our circuit, like many DMX converters sold in retail shops (some of which come at exorbitant prices), does not include full electrical isolation. This is not terribly important when using a DMX device **that's operating properly,** but could prove fatal for your computer if, unfortunately, a mains phase conductor of a defective projector or floodlight should come into contact with the DMX512 line. Forewarned is forearmed!

A PIC16C745

The PIC16C745, of which the block diagram can be found in **Figure 1,** is a low-cost microcontroller. However, it was one of the first to have a USB interface. In reality, it is a type 1.1 low-speed USB interface. The transmission rate of the USB bus in low speed mode is 1.5 Mbits/second.

The DMX512 bus speed is a 'measly' 250 kbits/s. The USB is six times faster, so where is the problem? Well, for one thing the USB standard defines two data transfer modes for low speed, Control transfer and Interrupt transfer. The control mode uses all of the bus bandwidth and is, according to the standard, reserved for USB receiver configurations. The Interrupt mode is intended for data transfer but we should note that it is limited to 800 bytes per second!

Out of spec!

With the above in mind we're more or less forced to use the 16C745 in a configuration that's not found in the USB

nverter

Housed inside an XLR connector!

standard. To do so, we have selected the Control transfer mode in order to exchange data between the computer and the microcontroller. Obviously, considering that the USB bus was not designed for that use, we had to write a special driver for this Microsoft Windows® application. The firmware source code for the microcontroller is available from our website at www.elektor-electronics.co.uk (file # **060129-11.zip**). Unfortunately, the copyrights for the driver source code rest with the author, hence this file cannot be made freely available. The pre-programmed PIC (order code **060129-41**) is however available from the Elektor SHOP (on the web or in this magazine)

Circuit diagram

A quick look at the diagram in **Figure 2** allows you to better understand why the circuit can be so compact: it has only two active components! The PIC16C745 (IC2) in its 28-pin SMD SOIC version is clocked at 6 MHz by X1, a miniature resonator with integrated capacitors. The internal microcontroller frequency is set to 24 MHz, thanks to its integrated PLL, thus lowering any risk of stray radiation which might occur when using a resonator at this frequency. The PIC generates the 3.3 V voltage necessary on 1.5 kW SMD resistor R1 connected to the D– line of the USB cable. A 220-nF SMD capacitor, C2, smoothes this voltage supplied directly by the microcontroller pin. Pins D+ and D– of the PIC are directly connected to the USB bus. The second capacitor, C1, is included to suppress fluctuations in the 5-volt supply voltage caused by PIC switching. The last electronic component in the circuit, IC1, is an RS485 bus driver for which we use the SMD SO8 package version. It is connected to the USART ((*Universal Synchronous & Asynchronous Receiver Transmitter*) of the 16C745 enabling it to be used bi-

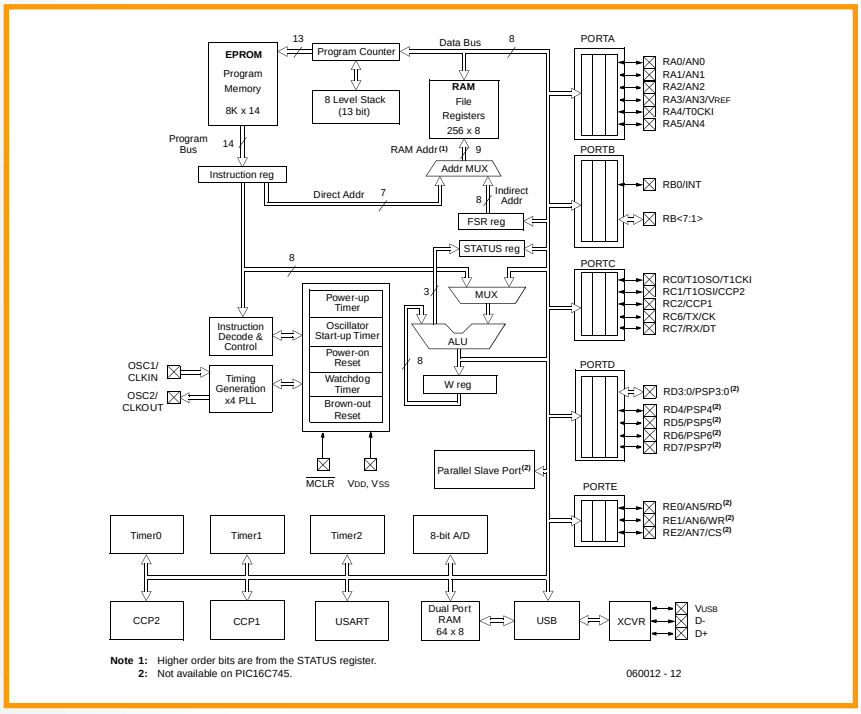


Figure 1. PIC16C745 architecture.

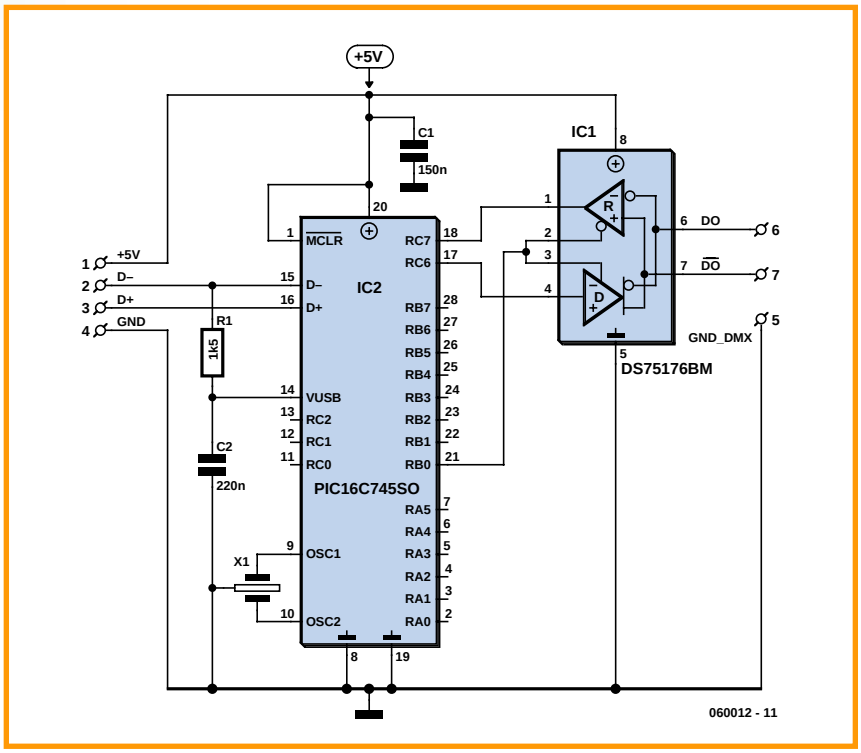


Figure 2. The circuit diagram of our converter is limited, in fact, to a PIC micro and an RS485 bus driver.

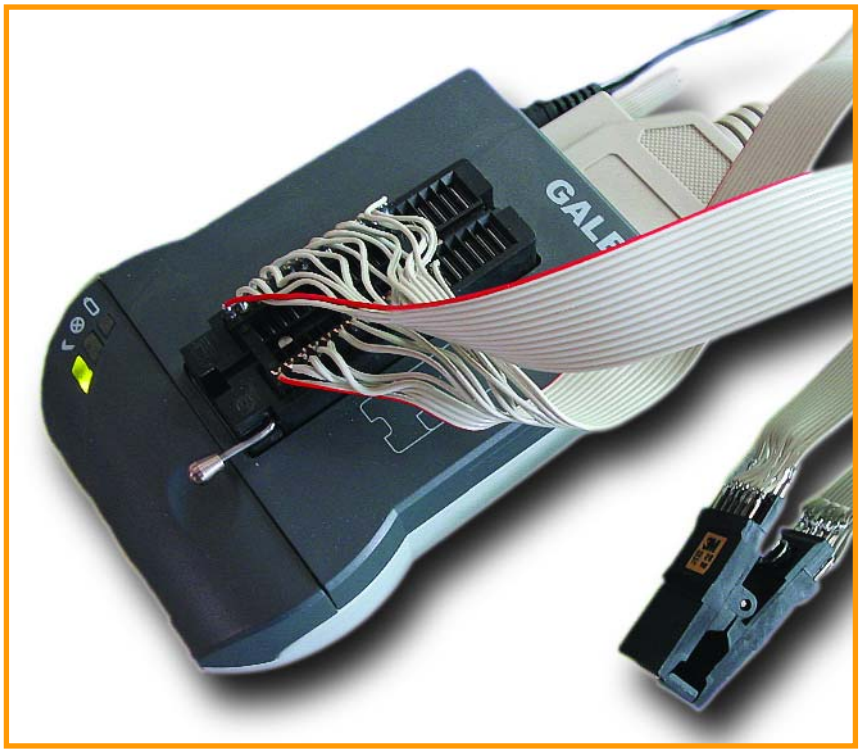


Figure 3. Not for the faint-hearted...

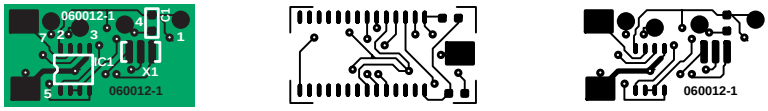
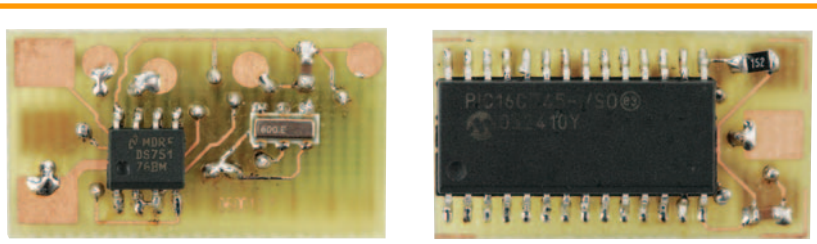


Figure 4. The PIC occupies almost all space at one of the board sides. This double-sided board is through-plated.



COMPONENTS LIST

Resistors
R1 = 1kΩ5 0.25W 5% (0805)

Capacitors
C1 = 150nF ceramic (0603)
C2 = 220nF ceramic (0603)

Semiconductors
IC1= DS75176BM (National Semiconductor)
IC2 = PIC16C745-I/SO, programmed, order code **060012-41**

Miscellaneous
X1 = 6MHz resonator, Murata CSTCR6M00G53-R0
XLR connector, Cannon type 10HC089 (e.g. www.distrelec.com, # 112242)USB A-A cable, 1.8m, standard
PCB, ref. 060012-1 from The PCBshop
Project software, free download # **060012-11.zip** from www.elektor-electronics.co.uk

directionally, in case you would like to modify the firmware of the PIC to use it as a DMX512 input. The non-inverting buffer output of the RS485 driver is connected to pin 3 of the XLR connector and the inverter output is connected to pin 2, since pin 1 is connected to ground. As far as the USB cable and connector are concerned, this is a moulded cable sold in retail stores or the one with your old mouse (USB, of course!). It has four wires plus shielding: a pair of untwisted, fairly thick wires for the 5 V power supply voltage and two thinner wires, twisted as pair, for data transmission. XLR connectors are supplied by many manufacturers. Here, a, Cannon type 10HC089 is used. It is important to use this XLR connector because a standard Neutrik connector does not have enough space to hold the circuit.

Programming the PIC

The PIC 16C745 micro has to be programmed before soldering it onto the board. If you're a home programmer, make sure you have a suitable DIL-to-SOIC adaptor with your programmer. Alternatively, as we did in our tests (see the photo in **Figure 3**), you can make one yourself using a DIL carrier, a piece of flatcable and a test clip for SOIC circuits. The hex (object code) file to burn into the PIC is called **firmware\usb2dmx.hex**. It is contained in archive file **060012-11.zip** which may be downloaded free of charge from our website. The PIC may also be purchased ready-programmed from the Elektor SHOP.

Heat up your soldering irons!

Populating the board requires some skills handling SMD parts but should not cause dramatic problems. Fortunately, the components used for this project are not as difficult to solder as, for example, an ARM processor in a BGA package with 278 balls, sized 14 mm x 14 mm!

The printed circuit board of which the top and bottom side artwork is shown in **Figure 4** is without doubt, one of the smallest we have ever published in *Elektor Electronics*.

You need to use a soldering iron with a fine tip and thin gauge solder. Start by soldering the PIC micro, IC2, into place (be careful to observe the correct polar-

ity), which then constitutes a base plane in order to solder the components on the other side of the circuit. The best option, so as to perfectly align the integrated circuit on the board, is to apply a bit of solder to two pads for corner pins of the device. Next, place the PIC and reheat the two solder terminals in order to create an initial attachment point for the component. If the component is perfectly positioned, the only thing left to do is to solder the remaining 26 pins. If not, reheat the corner pins and carefully realign the chip.

Next, solder R1 and C2 on this side by pre-tinning a pad, then placing the component with tweezers while keeping the pad at fusion temperature. Next, solder the other connection of the component. Use the same technique to solder the remaining components (IC1, C1, X1) on the other side of the board. X1 is the component that requires the most attention because it is more usually soldered using the 'reflow' technique.

Microsurgery

Next, we cut a USB type 'A-A' cable in half and strip it. The black wire is soldered to the 0 V pad (terminal 4), the red wire to the +5V pad (terminal 1), the green wire to the D+ pad (terminal 3) and finally the white wire to the D– pad (terminal 2). You'll find that this bit of the construction requires some dexterity in handling the solder iron,

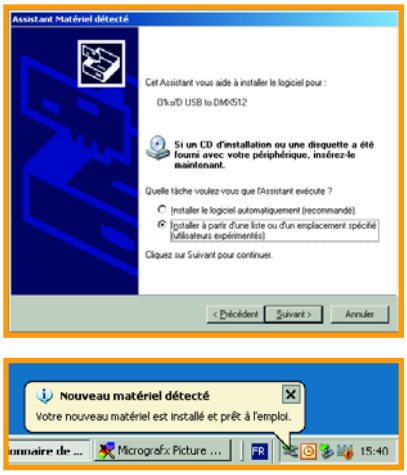

Assistant Matériel détecté
Cet Assistant vous aide à installer le logiciel pour :
Si un CD d'installation ou une disquette a été fourni avec votre périphérique, insérez-le maintenant.
Quelle tâche voulez-vous que l'Assistant exécute ?
Installer le logiciel automatiquement (recommandé)
Installer à partir d'une liste ou d'un emplacement spécifié (utilisateurs expérimentés)
Cliquez sur Suivant pour continuer.
< Précédent
Suivant >
Annuler
Nouveau matériel détecté
Votre nouveau matériel est installé et prêt à l'emploi.
MicrografX Picture ...
FR
15:40

Figure 5. If you are used to installing USB peripherals, this type of screen should look familiar.

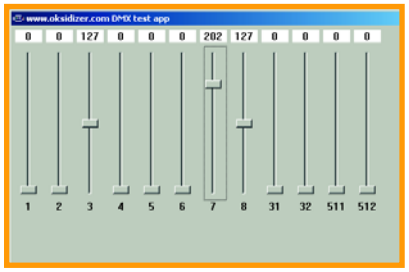


Figure 6. The 'test_cpp.exe' program is used for quick testing of our USB/DMX512 converter.

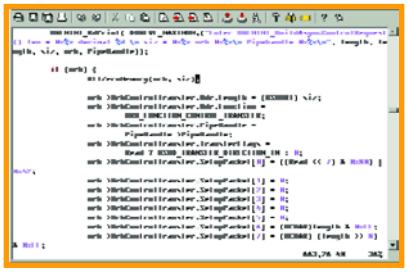


Figure 7. The purpose of the oGenInt.sys driver function is to shape the 'requests' sent by the USB bus.

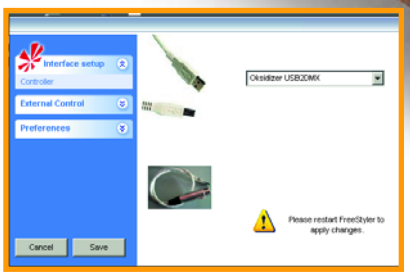


Figure 8. Settings screen in FreeStyler.

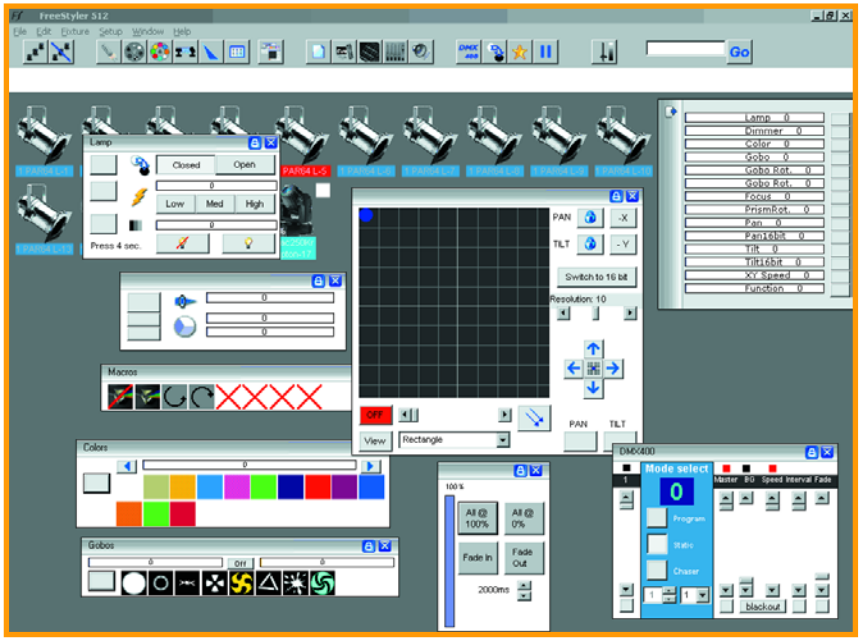


Figure 9. **The number of functions available in FreeStyler makes it quasi-professional.**

since there are no holes in the printed circuit. The cable shielding is soldered to the connector strip. The next step is to solder the circuit to the XLR connector, from which the rubber cable guide has been cut. Terminal 5 should be soldered to pin 1 of the XLR connector, terminal 6 to pin 3, and finally terminal 7 to pin 2.

Before applying a little glue to keep the USB cable in place and to close the XLR connector again, test the set-up by connecting it to your computer. When the new USB device is inserted for the first time, you will be asked to install the drivers provided in the .zip file **060012-11.zip (Figure 5)**. Once the drivers are installed, connect the XLR plug to your DMX512 equipment and launch the program **cpp_test\bin\test_cpp.exe** which is found in the same archive file. There you have it!

Software environment

PIC firmware

The assembly code of the PIC is derived from version 1.25 of the firmware provided on Microchip's website, the manufacturer of the PIC16C745.

We used version 1.25 because version 2.00 did not seem to function with the erasable PICs we had available. The file *usb_main.asm* contains an endless loop reading batches of data sent by the computer. These data are utilised in the *dmx512.asm* file that synchronises the USB reception with the transmission on the serial DMX512 bus. Also in this file we find the code that serves to generate the pause required at the end of each DMX field.

The test_cpp.exe program

This program, shown in action in **Figure 6**, is used to quickly test the operation of the USB/DMX512 converter. Its source code demonstrates the way to use the unique function exported from **DLL DasHard.dll**.

The really important bits happen in the **test_cppDlg.cpp** file. More specifically, the **CTest_cppDlg::OnVScroll** function copies the value of the cursors in the **OutDmx** output buffer. And the **CTest_cppDlg::OnTimer** function, called on at regular intervals, loads the DLL and obtains a pointer on the **OksidCommand** function during its first call. During the following calls, it simply passes the output buffer to the **OksidCommand** function.

The DLL DasHard.dll

This one links it all to the driver and, provided a converter is connected to the computer, opens a data stream with it. This stream is fed by a specific thread that loops as long as the DLL is used. Refer to the source code for more details.

The oGeniInt.sys driver

The driver (see the screenshot in **Figure 7),** of which the source code is regrettably not available, is in charge of shaping Control-type requests travelling on the USB bus. The **OGENINT.INF file** makes the driver installation possible. It creates the association between the driver with our USB module, thanks to the *Vendor ID* and *Product ID* identifiers that are specific to our application.

FreeStyler,
free DMX512 driver software.

FreeStyler is software written in Visual Basic that makes it possible to drive DMX512 equipment by indifferently using an impressive variety of converters for the parallel, USB, or Ethernet port. As shown in the screenshot in **Figure 8**, the latest version also functions with our circuit using the reference 'Oksidizer USB2DMX'. FreeStyler is available as a free download from the website run by the author of the program. It comes with a complete user manual.

The screen copy in **Figure 9** shows that FreeStyler offers a range of functions that may disconcert a beginner but will be welcomed as very useful by (DMX512-)enlightened amateurs and professionals.

(060012-1)

Internet links :

Author's website: http://www.oksidizer.com

http://membres.lycos.fr/epatix/dmx_512.htm

http://users.pandora.be/freestylerdmx/

http://www.beyondlogic.org/usbnutshell/

http://ogloton.free.fr/dmx_512/index.html